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(54) Seal for expandable tubular connections

Dichtung für erweiterbare Rohrverbindungen

Garniture d'étanchéité pour des assemblages tubulaires extensibles

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Description

[0001] The invention is related to threaded tubular joints usable in oil and gas well drilling and production, such as tubing, casing, line pipe, and drill pipe, commonly known collectively as oilfield tubular goods. More particularly, the invention relates to a seal for tubular joints for connecting male (pin) and female (box) members and preferably to a collapsing type seal.

Description of the Related Art

[0002] Threaded tubular connections are used for joining segments of conduits end-to-end to form a continuous conduit for transporting fluid under pressure. Oilfield tubular goods generally use such threaded connections for connecting adjacent sections of conduit or pipe. Examples of such threaded end connections designed for use on oilfield tubular goods are disclosed in U.S. Patent Nos. 2,239,942; 2,992,019; 3,359,013; RE 30,647; and RE 34,467, all of which are assigned to the assignee of this invention.

[0003] Document US-A- 4 707 001 discloses a seal for a conduit connection, comprising:

> a first sealing surface disposed proximal to an end of a mate portion of said connection;
> a second sealing surface disposed proximal to an end of a female portion of said connection, said first and said second seating surfaces substantially opposite each other upon connection of said male and female portions;
> a first clearance surface proximal to said first sealing surface on said male portion; and
> a second clearance surface proximal to said second sealing surface on said female portion, said first and second clearance surfaces and said first and second sealing surfaces contact each other so as to develop a contact pressure.

[0004] In U.S. Patent No. RE 30,647 issued to Blose, a particular thread form or structure is disclosed for a tubular connection that provides a strong joint while controlling the stress and strain in connected "pin" (male thread) and "box" (female thread) members to within acceptable levels. The pin member has at least one generally dovetail-shaped external thread whose width increases in one direction along the pin, while the box member has at least one matching generally dovetail-shaped internal thread whose width increases in the other direction. The mating set of helical threads provide a wedge-like engagement of opposing pin and box thread flanks that limit the extent of relative rotation between the pin and box members, and define a forcible make-up condition that completes the connection. In this thread structure, the angles of the flank shoulder, as well as the thread width, can be used to control the stress and strain preload conditions induced in the pin and box members for a given make-up torque. Thus, by tailoring the thread structure to a particular application or use, the tubular connection or joint is limited only by the properties of the materials selected.

[0005] As shown in Figure 1, a prior art tubular connection 10 includes a pin member 11 and a box member 12. Box member 12 has a tapered, internal, generally dovetail-shaped thread structure 14 formed thereon which is adapted for engaging complementary tapered, external, generally dovetail-shaped thread structure 15 formed on pin member 11 to mechanically secure the box 12 and pin 11 members in a releasable manner.

[0006] Internal thread 14 on tile box member 12 has stab flanks 18, load flanks 16, roots 20, and crests 24. The thread 14 increases in width progressively at a uniform rate in one direction over substantially the entire helical length of thread 14. External thread 15 of pin member 11 has stab flank, 19, load flanks 17, roots 21, and crests 25. The thread 15 increases in width progressively at a uniform rate in the other direction over substantially the entire helical length of thread 15. The oppositely increasing thread widths and the taper of threads 14 and 15, cause the complementary roots and crests of the respective threads 14 and 15 to move into engagement during make-up of the connection 10 in conjunction with the moving of complementary stab and load flanks into engagement upon make-up of the connection.

[0007] The pin member 11 or the box member 12 defines the longitudinal axis 13 of the made-up connection 10. The roots and crests of the box and pin members are flat and parallel to the longitudinal axis of the connection and have sufficient width to prevent any permanent deformation of the threads when the connection is made up.

[0008] An important part of any connection is a seal for keeping the conduit fluid pressure-tight at the connections. Typically connections will be designed to include metal-to-metal seals therein. Metal-to-metal seals have the advantage of not requiring gaskets or other additional sealing devices, which would typically have to be replaced periodically as the connections are coupled and uncoupled. Metal seals are created when contact pressure between two metal surfaces exceeds the fluid pressure to be sealed. Typically the contact pressures are created during make up of the connection.

[0009] More recently, oilfield tubular goods have been developed which can be radially expanded from their initial diameters after being installed for the intended application. See for example, R. D. Mack et al, *How in situ expansion affects casing and tubing properties*, World Oil, July 1999, Gulf Publishing Co., Houston, TX, for a description of radially expanding oilfield tubular goods. Radially expandable tubular goods have particular application as casing in oil and gas producing wells. It has been difficult to seal radially expandable tubular connections using metal-to-metal seals known in the art. It is one object of the present invention to obtain such a seal.

[0010] The present invention provides a seal for a radially expansible connection according to independent claim. Further advantageous features, aspect and details of the invention are evident from the dependent claims, the description and the drawings. The claims are intended to be understood as a first non-limiting approach of defining the invention in general terms.

[0011] The invention according to a specific aspect provides a seal for a radially expansible conduit connection or coupling. The seal preferably includes a first sealing surface disposed proximal to an end of a male portion of the connection, and a corresponding second sealing surface disposed proximal to an end of a female portion of the connection. It is preferred that the first and said second sealing surfaces are substantially opposite each other upon connection of the male and female portions. The seal may include a first clearance surface proximal to the first sealing surface on the male portion and a second clearance surface proximal to the second sealing surface on the female portion. The first and second clearance surfaces are preferably substantially opposite each other upon connection of the male and female portions. The first and second clearance surfaces, and the first and second sealing surfaces advantageously each have a diameter such that prior to radial expansion, the clearance surfaces do not contact each other. Upon radial expansion of the male portion and female portion after coupling together thereof, the clearance surfaces preferably remain out of contact and the sealing surfaces preferably contact each other so as to develop a contact pressure.

[0012] In one specific aspect, the clearance between the sealing surfaces prior to radial expansion of the connection is about 30 to 40 percent of the amount of radial expansion.

[0013] In a further aspect, the clearance between the clearance surfaces prior to radial expansion is about 50 to 55 percent of the amount of radial expansion.

[0014] In still another aspect, the sealing surfaces are in interference fit prior to radial expansion of the connection. After the radial expansion, the contact pressure between the sealing surfaces is increased.

[0015] In one advantageous aspect embodiment, the coupling is a threaded coupling including mating threads on the male and female portions of the coupling. The clearance surface on the male portion preferably is proximal to the thread end, and the clearance surface on the female portion is preferably proximal to the thread start in the threaded coupling embodiment.

Figure 1 shows a prior art tubular threaded connection.

Figure 2 shows a partial view of one embodiment of the connection seal of the invention prior to radial expansion of the tubular joints and connection.

Figure 3 shows a partial view of one embodiment of the connection seal of the invention after radial expansion of the tubular joints and connection.

DETAILED DESCRIPTION

[0016] Figure 2 relates to one example of a tubular connection 10A as used on radially expandable tubular goods. The example shown in Figure 2 is for a threaded coupling. Figure 2 is a cross-section through only one side of the threaded tubular connection 10A, and the view shown in Figure 2 should therefore be thought of as rotationally symmetric about the axis (not shown) of the tubular connection 10A. The tubular connection 10A is formed by joining a male-threaded "pin" member 30 to a female-threaded "box" member 32. The pin 30 and box 32 members have thereon corresponding threads 36 and 34, respectively, which when engaged provide axial coupling force to join tubular joints together. The threads 34, 36 can be any type known in the art for coupling together tubular goods, and may be a sealing type or a non-sealing type. The particular type of threads selected will depend as is known in the art, on the intended use of the tubular goods being joined by the connection 10A. The type of threads is not intended to limit the invention. It should also be noted that the connection 10A can be formed wherein segments of conduit (not shown separately) include a pin at both ends and are connected by a short segment having box members at both ends, the short segment being known as a "collar". The connection 10A can also be formed wherein each segment of conduit includes therein a pin at one end and a box at the other. Either conduit connection will work with this invention.

[0017] In the example shown in Figure 2, the box member 32 includes at its thread start end a clearance surface 42 and a sealing surface 44. The pin member 30 includes thereon at the end of the threads 36 a corresponding clearance surface 38 and scaling surface 40. The clearance surfaces 38 arid 42 on the pin member 30 and box member 32, respectively, each may be parallel to the axis (not shown) of the connection 10A each so as to define a generally cylindrical surface, or they may be tapered. Similarly, the sealing surfaces 40 and 44 may be parallel, but the sealing surfaces 40, 44 are preferably tapered as shown in Figure 2. Although the sealing surfaces 40, 44 as shown in Figure 2 are parallel to each other as well as being tapered, it should be understood that the sealing surfaces 40, 44 need not be parallel to each other. In the invention, the clearance between the clearance surfaces 38, 42 is greater than the clearance between the sealing surfaces 40, 44 prior to radial expansion of the pin member 30 and box member 32. The additional clearance between the clearance surfaces 38, 42 results in a radially-inward deformation of the seal surface area (particularly seal surface 44) on the box 32 when the box 32 is radially expanded, which results in a high contact pressure between the sealing surfaces 40, 44. In the embodiment shown in Figure 2, the clearance surface 42 on the box 32 has a larger internal diameter than does the seal surface 40 on the box 32 to provide the larger clearance between correspond-

ing clearance surfaces 38, 42 than the corresponding seal surfaces 40, 44. It is also possible to provide larger clearance between the clearance surfaces 38, 42 by making the clearance surface 42 on the pin 30 with a smaller external diameter than the sealing surface 44 on the pin 30. Any other combination of internal diameters on the box surfaces 38, 40 and external diameters on the pin surfaces 42, 44 which provides larger clearance between corresponding clearance surfaces 38, 42 will also work with the invention.

[0018] Although Figure 2 shows the sealing surfaces 40, 44 as having a small amount of clearance between them prior to radial expansion of the pin 30 and box 32, the sealing surfaces 40, 44 may also be in interference contact with each other. Where the sealing surfaces 40, 44 are in interference contact prior to radial expansion, after radial expansion the sealing surfaces 40, 44 will contact each other at a higher contact pressure than prior to expansion as long as the clearance surfaces 38, 42 remain out of contact after expansion.

[0019] The amount of clearance between the clearance surfaces 38, 42 prior to radial expansion will depend on, among other factors, the amount of radial expansion to be applied to the pin 30 and box 32, and the pre-expansion diameter of the pin 30 and box 32. Generally, large clearance where the amount of expansion is small, or small clearance where the amount of clearance is to be large are not highly desirable. A preferred amount of clearance between the sealing surfaces is about 30 to 40 percent of the amount of expansion to be applied, although other clearances will work with the invention, including interference fit, as previously explained. A preferred pre-expansion clearance for the clearance surfaces is about 50 to 55 percent of the amount of radial expansion, although other clearances will work with the invention. The important aspect is that the clearance surfaces 38, 42 retain some clearance therebetween after radial expansion of the box 32 and pin 30.

[0020] Figure 3 shows the connection 10A after radial expansion of the pin 30 and box 32. As can be seen in Figure 3, the scaling surfaces 40, 44 have been put into sealing contact with each other by reason of the radial expansion of the pin 30 and box 32. The clearance surfaces 38, 42 do not come into contact with each other as a result of the radial expansion of the pin 30 and box 32.

[0021] While the embodiment of the invention described herein includes a threaded coupling for joining segments of conduit, the invention does not require the use of threaded couplings. For example, J-slot connectors including locking pins on the pin end, with corresponding slog on the box end could provide axial coupling force to hold the pin and box together. Other types of couplings which do not use mating threads can also be devised by those skilled in the art.

[0022] According to a still further aspect of the invention there is provided a seal for a radially expansible conduit connection is disclosed. The seal includes a first sealing surface (40) disposed proximal to an end of a male portion (30) of the connection and a corresponding second sealing surface (44) diposed proximal to to an end of a female portion (32) of the connection. The first and said second sealing surfaces (40,44) are substantially opposite each other upon connection of the male (30) and female (32) portions. The seal includes a first clearance surface (38) proximal to the first sealing surface (40) and a second clearance surface (42) proximal to the second sealing surface (44). The first and second clearance surfaces (38,42) are substantially opposite each other upon connection of the male (30) and female (32) portions. The first and second clearance surfaces (38,42), and the first and second sealing surfaces (40,44) each have a diameter such that upon radial expansion of the male portion (30) and the female portion (32) after coupling together thereof, the clearance surfaces (38,42). remain out of contact while the sealing surfaces (40,44) contact each other so as to develop a contact pressure. In one embodiment, the clearance between the sealing surfaces (40,44) prior to expansion is about 30-40 percent of the amount of expansion. In another embodiment, the sealing surfaces (40,44) are in interference contact prior to expansion. In one embodiment, the clearance surfaces (38,42) have a clearance prior expansion, of about 50 to 55 percent of the amount of expansion. In a particular embodiment, the conduit connection is a threaded coupling (34,36).

Claims

1. A seal for a radially expansible conduit connection (10A), comprising:

   a first sealing surface (40) disposed proximal to an end of a male portion (30) of said connection;

   a second sealing surface (44) diposed proximal to an end of a female portion (32) of said connection, said first (40) and said second (42) sealing surfaces substantially opposite each other upon connection of said male and female portions;

   a first clearance surface (38) proximal to said first sealing surface (40) on said male portion (30); and

   a second clearance surface (42) proximal to said second sealing surface (44) on said female portion (32), said first (38) and second (42) clearance surfaces and said first (40) and second (44) sealing surfaces each having a diameter such that prior to radial expansion of said female (32) and said male (30) portions said

clearance surfaces (38,42), are proximal to each other and do not contact each other, and after said radial expansion said clearance surfaces (38,42), remain out of contact and said first (40) and said second (44) sealing surfaces contact each other so as to develop a contact pressure.

2. The seal as defined in claim 1, wherein at least one of said first and said second sealing surfaces (40,44) is tapered.

3. The seal as defined in claim 1, wherein said first and said second sealing surfaces (40,44) are parallel to an axis of said threaded connection.

4. The seal as defined in any one of the preceding claims, wherein said first and said second sealing surfaces (40,44) do not contact each other prior to said radial expansion.

5. The seal as defined in claim 4, wherein said first and said second sealing surfaces (40,44) prior to said radial expansion have a clearance therebetween of about 30 to 40 percent of the amount of said radial expansion.

6. The seal as defined in any one of claims 1 to 3, wherein said first and said second sealing surfaces (40,44) are in interference contact with each other prior to said radial expansion.

7. The seal as defined in any one of the preceding claims, wherein a clearance between said clearance surfaces (38,42) prior to said radial expansion is about 50 to 55 percent of the amount of said radial expansion.

8. The seal as defined in any one of the preceding claims, wherein said second clearance surface (42) has a larger internal diameter than said second sealing surface (44).

9. The seal as defined in any one of the preceding claims, wherein said first clearance surface (38) has a smaller external diameter than said first sealing surface (40).

10. The seal as defined in any one of the preceding claims, wherein said conduit connection comprises a threaded connection (34,36), wherein said first clearance surface (38) on said male portion (30) is proximal to a thread (34) end thereon, and said second clearance surface (42) on said female portion (32) is proximal to a thread (36) start thereon.

Patentansprüche

1. Dichtung für eine radial erweiterbare Rohrverbindung (10A), umfassend:

eine erste Dichtfläche (40), welche nahe zu einem Ende eines Einführ-Bereichs (30) der Verbindung angeordnet ist;

eine zweite Dichtfläche (44), welche nahe zu einem Ende eines Aufnahme-Bereichs (32) der Verbindung angeordnet ist, wobei die erste Dichtfläche (40) und die zweite Dichtfläche (44) einander im Wesentlichen gegenüber liegen beim Verbinden des Einführ- und des Aufnahme-Bereichs;

eine erste Abstandsfläche (38) nahe der ersten Dichtfläche (40) an dem Einführ-Bereich (30); und

eine zweite Abstandsfläche (42) nahe der zweiten Dichtfläche (44) an dem Aufnahme-Bereich (32), wobei die erste Abstandsfläche (38) und die zweite Abstandsfläche (42) und die erste Dichtfläche (40) und die zweite Dichtfläche (44) jeweils einen solchen Durchmesser aufweisen, dass vor radialer Erweiterung des Aufnahme-Bereichs (32) und des Einführ-Bereichs (30) die Abstandsflächen (38, 42) einander nahe sind und einander nicht kontaktieren, und dass nach der radialen Erweiterung die Abstandsflächen (38, 42) ohne Kontakt verbleiben und die erste Dichtfläche (40) und

die zweite Dichtfläche (44) einander kontaktieren, so dass sich ein Kontaktdruck entwickelt.

2. Dichtung gemäß Anspruch 1, wobei die erste Dichtfläche (40) oder/und die zweite Dichtfläche (44) sich verjüngend ausgebildet ist.

3. Dichtung gemäß Anspruch 1, wobei die erste Dichtfläche (40) und die zweite Dichtfläche (44) parallel zu einer Achse der Gewindeverbindung sind.

4. Dichtung gemäß einem der vorangehenden Ansprüche, wobei die erste Dichtfläche (40) und die zweite Dichtfläche (44) einander nicht kontaktieren vor der radialen Erweiterung.

5. Dichtung gemäß Anspruch 4, wobei die erste Dichtfläche (40) und die zweite Dichtfläche (44) vor der radialen Erweiterung einen Abstand von etwa 30 bis 40 Prozent des Betrags der radialen Erweiterung dazwischen aufweisen.

6. Dichtung gemäß einem der Ansprüche 1 bis 3, wo-

bei die erste Dichtfläche (40) und die zweite Dichtfläche (44) in Eingriff-Kontakt vor der radialen Erweiterung sind.

7. Dichtung gemäß einem der vorangehenden Ansprüche, wobei ein Abstand zwischen den Abstandsflächen (38, 42) vor der radialen Erweiterung etwa 50 bis 55 Prozent des Betrages der radialen Erweiterung ist.

8. Dichtung gemäß einem der vorangehenden Ansprüche, wobei die zweite Abstandsfläche (42) einen größeren Innendurchmesser aufweist als die zweite Dichtfläche (44) .

9. Dichtung gemäß einem der vorangehenden Ansprüche, wobei die erste Abstandsfläche (38) einen kleineren Aussendurchmesser aufweist als die erste Dichtfläche (40).

10. Dichtung gemäß einem der vorangehenden Ansprüche, wobei die Rohrverbindung eine Gewindeverbindung (34, 36) umfasst, wobei die erste Abstandsfläche (38) an dem Einführ-Bereich (30) nahe einem Gewindeende (34) daran ist, und wobei die zweite Abstandsfläche (42) an dem Aufnahme-Bereich (32) nahe einem Gewindeanfang (36) daran ist.

Revendications

1. Joint d'étanchéité pour raccord dilatable radialement (10A), comprenant :

une première surface d'étanchéité (40) disposée proximale à une extrémité d'une portion mâle (30) dudit raccord ;
une seconde surface d'étanchéité (44) disposée proximale à une extrémité d'une portion femelle (32) dudit raccord, ladite première (40) et ladite seconde (42) surfaces d'étanchéité étant sensiblement opposées l'une à l'autre lors de la connexion desdites portions mâle et femelle ;
une première surface de jeu (38) proximale à ladite première surface d'étanchéité (40) sur ladite portion mâle (30) ;
une seconde surface de jeu (42) proximale à ladite seconde surface d'étanchéité (44) sur ladite portion femelle (32), lesdites première (38) et seconde (42) surfaces de jeu et lesdites première (40) et seconde (44) surfaces d'étanchéité ayant chacune un diamètre tel qu'avant la dilatation radiale desdites portions femelle (32) et mâle (30), lesdites surfaces de jeu (38,42) sont proximales l'une à l'autre et ne sont pas en contact l'une avec l'autre et, qu'après ladite dilatation radiale, lesdites surfaces de jeu (38,42) restent hors de contact et lesdites première (40) et seconde (44) surfaces d'étanchéité sont en contact l'une avec l'autre de façon à développer une pression de contact.

2. Joint d'étanchéité selon la revendication 1, dans lequel l'une au moins desdites première et seconde surfaces d'étanchéité (40,44) est effilée.

3. Joint d'étanchéité selon la revendication 1, dans lequel lesdites première et seconde surfaces d'étanchéité (40,44) sont parallèles à un axe dudit raccord fileté.

4. Joint d'étanchéité selon l'une quelconque des revendications précédentes, dans lequel lesdites première et seconde surfaces d'étanchéité (40,44) ne sont pas en contact l'une avec l'autre avant ladite dilatation radiale.

5. Joint d'étanchéité selon la revendication 4, dans lequel lesdites première et seconde surfaces d'étanchéité (40,44) ont, entre elles, avant ladite dilatation radiale, un jeu compris entre environ 30 et 40% de la quantité de ladite dilatation radiale.

6. Joint d'étanchéité selon l'une quelconque des revendications 1 à 3, dans lequel lesdites première et seconde surfaces d'étanchéité (40,44) sont en contact d'interférence, l'une avec l'autre, avant ladite dilatation radiale.

7. Joint d'étanchéité selon l'une quelconque des revendications précédentes, dans lequel existe, avant ladite dilatation radiale, un jeu entre lesdites surfaces de jeu (38,42) d'environ 50 à 55% de la quantité de ladite dilatation radiale.

8. Joint d'étanchéité selon l'une quelconque des revendications précédentes, dans lequel ladite seconde surface de jeu (42) a un plus grand diamètre interne que ladite seconde surface d'étanchéité (44).

9. Joint d'étanchéité selon l'une quelconque des revendications précédentes, dans lequel ladite première surface de jeu (38) a un plus petit diamètre externe que ladite première surface d'étanchéité (40).

10. Joint d'étanchéité selon l'une quelconque des revendications précédentes, dans lequel ledit raccord comprend un raccord fileté (34,36), ladite première surface de jeu (38) sur ladite portion mâle (30) est proximale à une fin de filetage (34) sur celui-ci, et ladite seconde surface de jeu (42) sur ladite portion femelle (32) est proximale à un début de filetage (36) sur celui-ci.

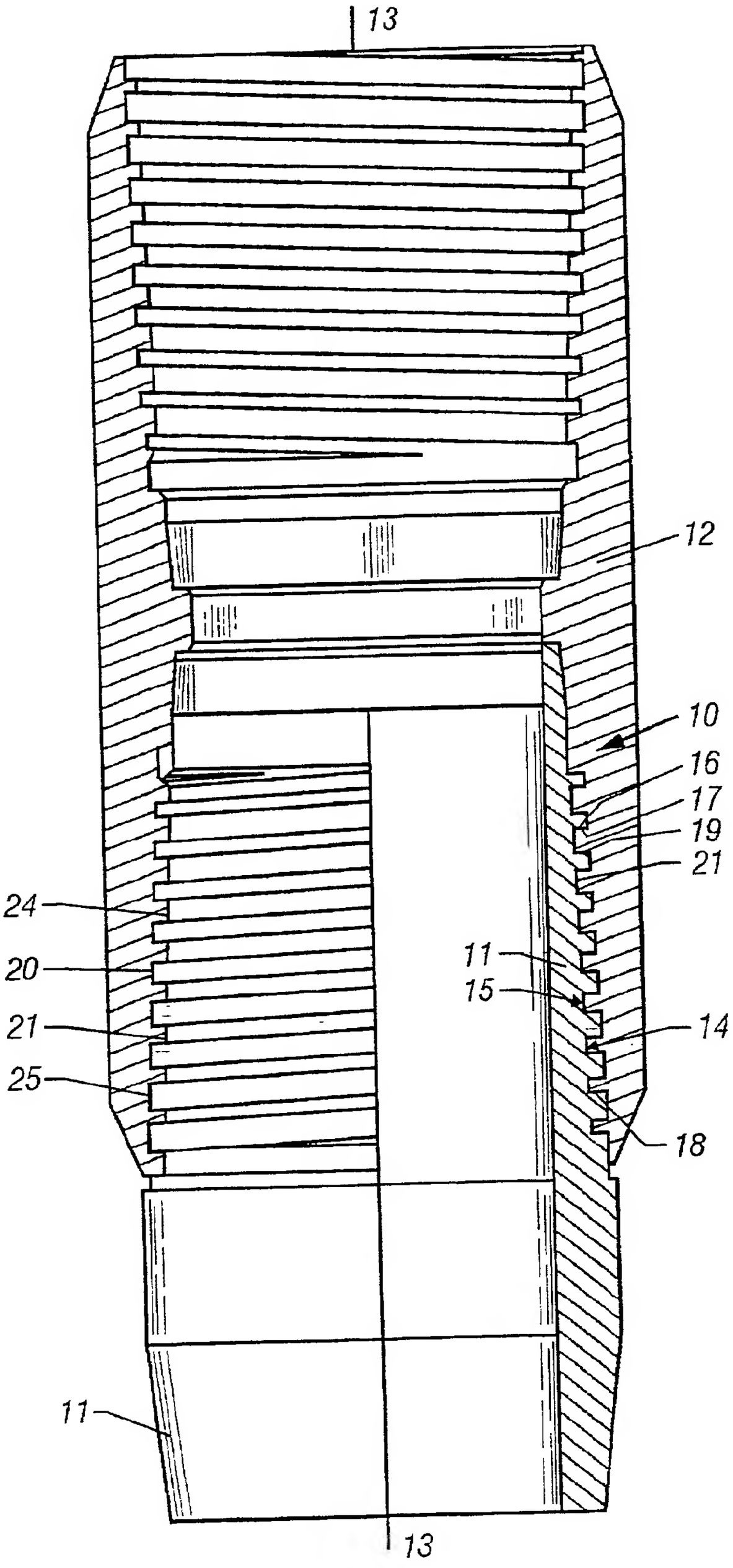

FIG. 1
(Prior Art)

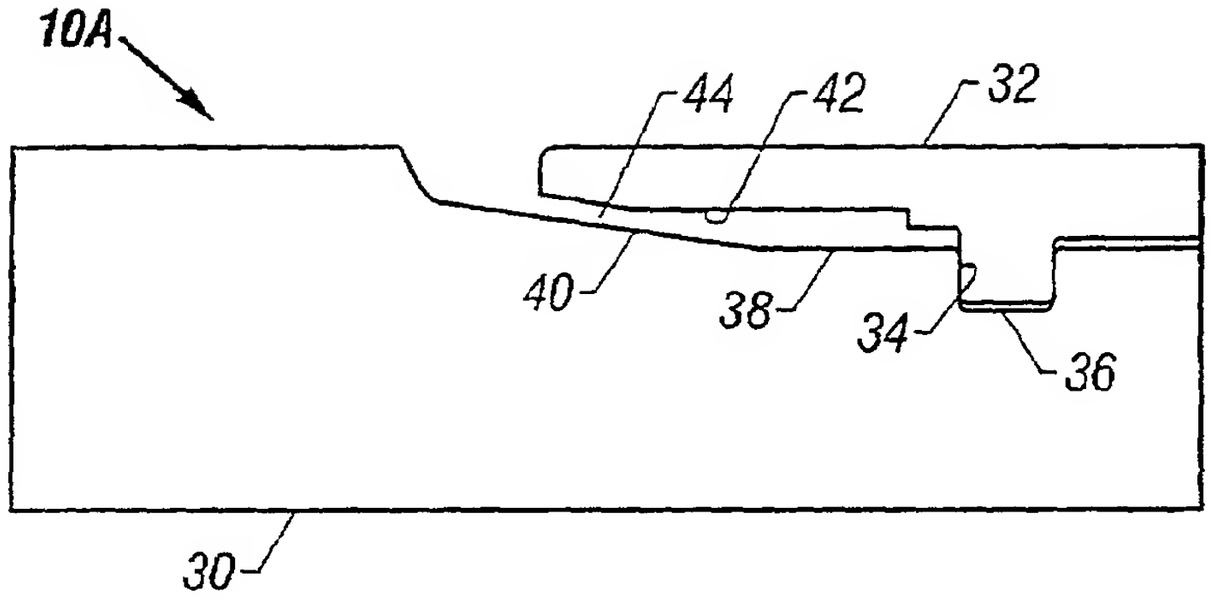

FIG. 2

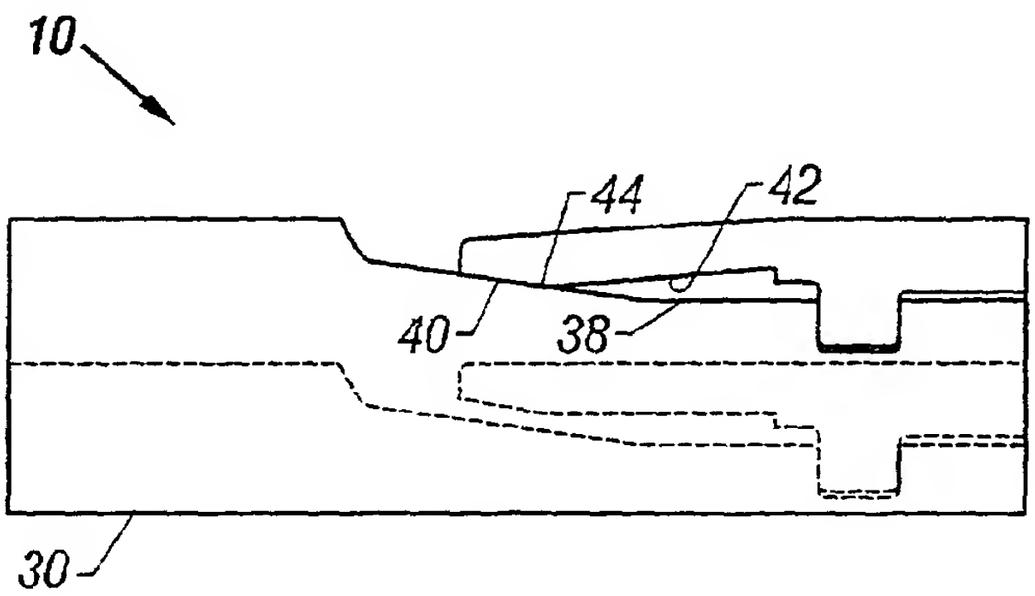

FIG. 3